

Examination 4

CSC140 Foundations of Computer Science

Due at 9 a.m. on Wednesday, March 2, 2016

1. At the heart of the selection sort algorithm is an algorithm that searches.
 - (a) Is the search from left to right or is it from right to left?
 - (b) Is the search in the sorted part of the list or is it in the unsorted part of the list?
 - (c) Does the search include an examination of every element in that part of the list that it searches?

2. At the heart of the insertion sort algorithm is an algorithm that searches.
 - (a) Is the search from left to right or is it from right to left?
 - (b) Is the search in the sorted part of the list or is it in the unsorted part of the list?
 - (c) Does the search include an examination of every element in that part of the list that it searches?

3. Both the selection sort and the insertion sort algorithms are $O(N^2)$ algorithms.

Suppose that you have two lists. One list contains 1000 items. The other list contains 5000 items. How much more time should you allow to sort the longer list if you are using the selection or insertion sort algorithms?

4. Although both the selection sort and the insertion sort algorithms are $O(N^2)$ algorithms, the insertion sort can be faster than the selection sort.
 - (a) Under what circumstances will the insertion sort be faster?
 - (b) What accounts for the greater speed?

5. At the heart of the merge sort algorithm is an algorithm that merges two already sorted lists to make one larger sorted list.

This operation requires three loops, yet the computer will execute only two of the loops in any call to the `merge()` method.

Explain.

6. Sometimes a recursive algorithm is a better choice than the alternatives even when the use of recursion does not reduce the number of operations that the computer must execute. What might a good reason for preferring a recursive method be when recursion does not make the computation faster?
- 7.

$$\log_2 1024 = 10$$

When I ask “what is the logarithm base 2 of 1024?” we are asking “how many times must I multiply 2 times itself to get 1024?”

$$\begin{aligned} 2^{10} &= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \\ &= 1024 \end{aligned}$$

How could I also define the logarithm with a question about divisions?

8. The merge sort is a divide and conquer algorithm. It reduces the problem of sorting a large list into the problem of sorting two smaller lists. It proceeds by repeatedly dividing bigger lists into smaller lists until what condition is satisfied?
9. Merge sort is an $O(N \log N)$ algorithm. Selection sort and insertion sort are $O(N^2)$ algorithms. Let $N = 1024$.
- (a) $N^2 = ?$
 (b) $N \log_2 N = ?$
10. Here is the declaration and definition of a list that can hold objects that each model a color.

```
List<Color> palette = new ArrayList<>();
```

Suppose that you have defined a class that models a weight. Write the code that creates a list that can hold objects that each model a weight.

11. When declaring a List variable (including ArrayLists), a programmer can specify the type of elements that the list may hold. That type must be a reference type.

Here is another way of saying the same thing: Instances of Java’s ArrayList class can hold any kind of object but it can only hold objects—it cannot hold primitive types like **int**.

Still, Java programmers do have a way of storing whole numbers in lists. How do they do it?

12. Here is code that prints the values of all integers in an array.

```
// Code that defines an integer constant SIZE not shown.

int [] data = new int [ SIZE ];

// Code that fills array with integers not shown.

for( int i = 0; i < data.length; i++ ) {
    System.out.println( data[i] );
} // for
```

Suppose that you have been given a list of integers rather than an array of integers.

```
// Code that defines an integer constant SIZE not shown.

List<Integer> data = new ArrayList<>();

// Code that fills list with integers not shown.
```

Write the code that prints the values of all integers in the list.

13. View Dorothy Denning’s TEDx talk titled “Open & Back Doors: Why Cyber Crime is a Growing Threat.” There is a link on our courses Moodle site and [here](#).

Learn who Dorothy Denning is. Take notes on the talk. Summarize Denning’s presentation in 256 to 512 words. Come to class on Wednesday prepared to discuss what you have learned.

14. Write a program that includes two classes.

Time One class will model a time. It will contain...

- instance variables to hold the number of hours and minutes
- a constructor
- a method named toString() that has no parameters and returns a printable representation of the time as a String
- a method named add() that has one parameter (another Time) and returns the sum of **this** Time and the parameter

TimeTester The other class will contain a main() method. The main() method will...

- create two Times
- add the two Times
- print their sum of the two Times